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PRACTICAL HINTS ON SUGARCANE CULTIVATION

IMPORTANCE OF INSECTS IN AGRICULTURE

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*(The responsibility of facts or opinions rests with the several authors of the articles)*

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# PRACTICAL HINTS ON SUGARCANE CULTIVATION IN MYSORE

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There have been, of late, several enquiries from established, as well as prospective, cane-growers, seeking information on various aspects of sugarcane cultivation, such as the proper time of planting, varieties suited to particular localities and manures to be applied. This short note is intended as a general guide on practical methods to be adopted in raising a profitable crop of sugarcane. While special problems peculiar to any individual estate will receive, as usual, the careful attention of the Department, it is hoped, that this note will provide answers to such questions as are common to all cane-growers. The information given here is based on the results of experiments and experience gained during the past 25 years.

*Selection of the Field.*—In selecting a field for sugarcane, the basic needs of the crop should be kept in view. Compared to other field crops, sugarcane has a long growing period and remains on the field from 12-18 months, depending upon the part of the year during which it is planted. It requires a fairly large amount of water to grow and mature, but will not tolerate water-logging or excessive moisture in the soil. The field selected must therefore have an adequate supply of irrigation water and must possess a fair capacity for retaining moisture, being at the same time well drained. Sugarcane can be grown on a variety of soil types ranging from light sandy soils to medium clay loams. In general, sugarcane can profitably be raised on all garden land, most of the medium loams under the *Ayakat* of tanks, and light sandy soils with an assured supply of irrigation.

*Preliminary Tillage.*—(*a*) It is always good to raise a crop of green manure on the field and incorporate it into the soil before bringing it under sugarcane. The green manure crop should be sown about 3 months before the time selected for planting cane. For this purpose, the land is ploughed once or twice, and 1 cwt. of superphosphate is applied broadcast and incorporated to the soil. The green manure is then sown. Sunhemp, cowpea and horsegram are suitable for this purpose. It is advantageous to mix the three in equal parts and sow them at the rate of 30 seers per acre. This ensures a

luxurious crop of green manure. Sunhemp or cowpea by itself can be sown but the advantage of sowing a mixture is that, if one of the crops fail, the other two at least will grow up and provide the necessary green manure. Besides, sunhemp is liable to heavy infestation by caterpillers many a time, which affects the normal growth to a great extent. It takes from 7 to 9 weeks for the plants to flower. The crop must be cut down and ploughed into the soil within 8-10 days of flowering, as otherwise, it will get woody and takes a long time to get decomposed in the soil. The growing and incorporating of green manure helps to build up the fertility of the soil by improving its texture and its water-retaining capacity. It also adds to the soil a considerable amount of much-needed nitrogen. The application of superphosphate to the green manure crop helps to get a heavy yield of green manure and provides the necessary phosphate for the subsequent cane crop.

(*b*) After the green manure gets decomposed, which takes about 3 weeks, the land should be ploughed 3 or 4 times at intervals of a week, until a fine tilth is obtained. The ideal to be aimed at is a fine pulverised soil without large clods. 5 to 10 cartloads of farmyard manure or well decomposed compost are applied before the final ploughing and incorporated into the soil. The land should then be disced to break down clods, if any left over, levelled with a levelling board and furrows opened. In the light soils, furrows can conveniently be opened with a mouldboard plough. In heavy soils, a plough furrow is first opened and this is deepened with a *mumti*. The most satisfactory distance between the furrows has been found to be 3' and the minimum depth of the furrow should be 9" from the surface.

After the furrows are opened, irrigation channels should be opened both across the furrows and in line with them. The number of channels to be opened depends upon the nature of the soil and the location of the field, but in general one channel every 30 yards is found to be adequate (Drainage channels for the excess water to drain off should also be opened around the field).

*Choice of the Variety*.—It is desirable to bestow great care in the selection of the variety to be planted. The performance of a variety depends upon various factors, such as the type of soil, rainfall and irrigation and time of planting. Thick canes generally do well on light and fertile soils, while medium to thin types are suitable for heavy soils and areas of restricted water-supply, as they are able to stand drought to a great extent. A number of improved varieties under both types have been evolved by the Department. Of these, Co. 419, H.M. 320, Cheni No. 8 and I.C. 26 among thick canes and H.M. 661, I.C. 8 and H.M. 645 among medium canes have already

become established. Besides these, there are a few promising varieties, *viz.*, I.C. 136, I.C. 203, I.C. 215, which after critical tests, both on Government Farms and cultivators' fields have proved themselves to be high-yielding types. As the varietal response varies under different soil and climatic conditions, it is better to grow the established variety of the locality in the first instance and grow one or more of the improved varieties along with it on a small scale and select the best among them for further plantings. The Department is always ready to supply seed setts of the improved varieties and to assist in other ways in conducting varietal tests on cultivators' fields. A list of such varieties available for distribution together with their description, is appended at the end of the note.

Individual growers who contemplate bringing a large area under cane would do well to space out the period of planting, so that ripe cane is available throughout the crushing season and loss due to deterioration of cane is avoided. This can also be achieved by planting part of the field with an early maturing variety and beginning the crushing season with this variety.

*Selection of Seed Setts.*—It is a common practice among cane-growers to harvest the cane when mature and use the tops of the canes as setts for the next crop. These top setts give a good germination and a close stand and there is nothing to be said against their use, as long as the crop is healthy and the seed setts are free from insect pests and diseases. But their use is possible only when the planting and harvesting seasons coincide. Also, in the case of varieties which arrow, the tops are liable to get pithy and consequently result in low percentage of germination.

Where whole canes are cut up and used as seed, it is necessary to use young canes, viz., 8-10 months old. If older cane is used, only the top half of the cane in which the buds are fresh and young should be used for setts and the rest milled for jaggery. Since a healthy and vigorous seed ensures a rich harvest, it always pays to raise a separate field of sugarcane exclusively for seed purposes. This is particularly so where cane is grown extensively, *i.e.*, under large tanks or river channels. The field intended for seed should be planted late in the season, so that it will be about 9-10 months old when it is to be cut up for seed next season. It should be adequately manured and carefully protected from pests and diseases.

It is advisable to soak the setts for a day in water prior to planting. This ensures good germination, and kills out any insect pests which the setts may harbour. Soaked setts should, however, not be left exposed for long periods on the field, but must be planted as soon as practicable.

*Planting.*—After applying manure in the furrow, furrows should be irrigated, till the soil is fully saturated with moisture, and setts should then be placed on the soil, held with the buds sideways and pressed gently into the soil. Planting in this manner gives all the three buds on the sett, a fair chance to germinate and grow. The depth to which the sett should be pushed in, depends on the nature of the soil, being deeper in light sandy soils than clayee loams. On the average, a layer of about 2-3" of soil should cover the sett.

*Seed Rate.*—Ten to twelve thousand three-buded setts per acre are usually sufficient. In areas of scarce water-supply, a closer spacing upto 16,000 setts may be necessary.

*Weeding.*—It is hardly necessary to emphasise the importance of weeding. It is a well-known fact that weeds reduce yields by competing for water and manure with the main crop. Weeding operation is an essential item in cane cultivation. Weeding should be done once at 6-7 weeks after planting, *i.e.,* when the setts have fully germinated. One or two more weedings at intervals of 8 weeks is usually necessary. By the time the crop is 4 months old, it will have tillered completely and closed in, giving hardly any chance for any more weeds to grow.

*Earthing Up.*—The young cane crop should be earthed up twice. The first earthing up should be done at 6-7 weeks, *i.e.,* after the first weeding is over. The soil between the furrows is ploughed up and worked up to the side of the plants with a mouldboard plough or by means of *kunte.* At this stage, the earthing up should be light, *i.e.,* the soil should cover only the base of the plants, so that tillering is not hindered. When the crop is about 12-14 weeks old, a second earthing up is given, by ploughing up the land between furrows and pushing the soil to the side of the plants, so that the original ridge becomes the furrow and the soil stands to a height of 8-10" around the cane stool. Application of manure to the crop can be done concurrently with the earthing up as indicated in the section on 'Manuring'.

*Irrigation.*—As already stated, the sugarcane crop requires an adequate amount of soil moisture at all stages of its growth. It is therefore necessary to irrigate the crop during the summer months. The main cane planting season in the State is from January to April and heavy rains occur usually after June. The young crop has therefore to be irrigated once a week until it is 12-13 weeks old. Thereafter an irrigation once in 10-12 days, till the rains set in and again after cessation of rains, upto the time of harvest is usually necessary.

The frequency of irrigation naturally depends on the nature of the soil and other factors. On soils of a light sandy nature, more frequent irrigation is necessary than on heavier soils. Also, a heavily manured crop requires more water than a poorly manured one.

*Manuring.*—Under Mysore conditions, sugarcane does not seem to require any potash, as the soils are adequately provided in this respect. The application of phosphate, in furrows, in the usual way, has not been found to increase yields but there is evidence to show that placement of the phosphate at a depth of 3-6" below the level of the setts improves yield. In any case, an application of 20 lb. of $P_2O_5$ (4-5 local maunds of superphosphate) is necessary, in the interest of balanced nutrition. It is best to apply this to the green manure crop, as stated earlier, or if this has not been done, to apply it deep in the furrows at the time of planting cane.

Nitrogenous manures are absolutely necessary for raising a remunerative crop of sugarcane, as our soils are particularly poor in nitrogen. The chief sources of nitrogenous fertilizers at present available are, green manures, composts and farmyard manures, oilcakes and ammonium sulphate. The use of green manure and composts has already been indicated under preparatory tillage. If farmyard manure is available, a second application at 5-10 cartloads can be made at the time of final earthing up.

The chief oilcakes in use are groundnut cake and castor cake. Groundnut cake is twice as rich in nitrogen as castor cake. The oilcakes are applied best as a top dressing in two doses, once at the time of light earthing up and again at the final earthing up.

Ammonium sulphate is a fertilizer, which supplies readily available nitrogen at a rapid rate ensuring a vigorous stand of crop. This should be applied in two or three doses, the first dose being applied in the furrows at planting and the rest along with the oilcakes.

It is difficult to state with exactness, the quantities of the oilcakes and ammonium sulphate to be applied, as it depends upon the nature of the soil and other factors. As a general guide, the following quantities may be taken as adequate.

*Light Sandy Soils.*—1-1½ tons of groundnut oilcake or 2-3 tons of castor cake in two equal doses + 7-8 cwt. of ammonium sulphate in three equal doses as indicated.

*Heavy Soils.*—½-¾ ton of groundnut oilcake or 1-1½ tons castor cake in two doses + 5 cwt. ammonium sulphate in two equal doses (2 and 3 cwt.).

Manures are utilised by the crop only in the presence of adequate soil moisture and therefore care should be taken to irrigate a heavily manured crop adequately, in order to obtain proper yields.

*Time of Planting and Harvest.*—The main planting season for sugarcane in the State (except for the area around the Sugar Factory at Mandya), commences in January and ends in April. This is so

because sugarcane usually follows paddy and paddy is harvested about December. In some localities cane is also planted during the months October-November. In the Factory zone, the planting season is confined to July-November of each year.

The time of harvest depends upon the season of planting. Cane planted between July and November takes a longer time to mature, *i.e.*, from 14-15 months, but gives a heavier yield than that planted after January. When the planting is done during January-April, the crop is ready for harvest in about 12 months. Since most cane varieties flower during October-November and the flowered stalks cease to grow, it is better to plant cane as early as possible in the season, so that the crop gets a long period of growth. If for any reason planting has to be done late, it is better to plant varieties which do not flower at all or flower sparsely.

There is a prevailing impression among cane-growers that when a cane flowers it is ripe for harvest. This is not strictly so. It is true that when a cane stalk puts up the arrow it stops growing, but the juice quality continues to improve for a further 2 months or so, so that the juice becomes richer and more sweet. Also, not all the stalks in a stool flower (except in a few varieties), and the non-flowered stalks continue to improve both in weight and sugar content. In most established varieties, the quality of the crop continues to be good for a few months after flowering.

For cane planted in the main season, harvest can be taken up when the crop is 12 months old and continued till the middle of April. After that date, the quality of juice suffers, and consequently the chance of obtaining good jaggery becomes remote.

For cane planted in *adsali* (July-November) harvest can be taken up from October onwards or 14 months after planting and completed as soon as possible.

When harvesting cane, the stalks must be cut flush with the ground. The bottom portions of the canes are richer in sugar and to leave long stumps would result in great loss of sugar. Besides, where ratooning is in practice, cutting flush with the soil helps good ratooning. The harvested cane must be milled with the least possible delay and in any case not later than 48 hours after harvest. Long storage of cut canes during summer causes serious deterioration in the quality of juice and jaggery. The juice gets sour and the jaggery becomes dark and soft.

*Pests and Diseases.*—The most serious pests of sugarcane are the top shoot borer and stem borer. The top shoot borer attacks the growing tip, and the plant ceases to grow. The stem borer gets into the soil and bores into the stem. The stem borer is most active when

the crop is young. A field attacked by the stem borer can be recognised by the presence of dead hearts. These are the dried and dead central blade of the young plant.

For the control of these pests, the following recommendations of the Entomologist should be followed :

*Top Shoot Borer.*—(*i*) Collect the egg masses and put them in a tin with a perforated lid and place the tin in the field. Natural parasites of the borers emerge and attack other eggs on the plant and kill them.

The egg masses occur on leaves of the cane plant and can easily be recognised.

(*ii*) Collect the borer moths and kill them.

*Stem Borer.*—(*i*) A field infested by the stem borer can be easily recognised by the appearance of dead hearts. These dead hearts should be cut to the level of the soil, collected and burnt. They contain the grubs of the borer and collection and killing the dead hearts kills the grubs.

Remove the partly opened first leaf-sheaths and earth up the crop lightly, as soon as germination is complete and in any case not later than 7 weeks.

(*ii*) Obtain a supply of Trichogramma parasites from the Government Entomologist and release them in the field.

*Recommended Varieties.*—One of the chief factors that effect the yield is the variety, and the success of agricultural enterprise quite often is determined by the choice of the right variety. It is a well-known fact that a variety suitable to one locality and set of conditions, is not necessarily suited to a different locality. Hence it is necessary to select for cultivation only such varieties as are best suited to the particular soil and climatic conditions. The Department is testing the suitability of improved varieties to different localities by growing them in the various Government Farms under standard conditions and comparing their performance. The best of these are then issued to cultivators on a trial basis and their performance on their field is watched.

The following indicates the most important varieties available for distribution. It is upto enterprising cane-growers to obtain and grow them on their own lands and help to spread the best of them in their respective localities.

H.M. 320 : This variety occupies at present 13,000 acres and is prized for its good quality jaggery. It has a hard rind which resists the attack of field rats and jackals. It gives a good extraction (60-63 per cent.) and a rich juice which produces a jaggery of high quality. Its average yield is 30-35 tons but much higher yields are

obtained under favourable conditions, the maximum recorded yield being 100 tons per acre. It ripens in about 12 months and can be planted over a wide season without seriously effecting yield or quality. It does not arrow in most localities and even where it does, the arrowing is very sparse. It is also becoming popular as a chewing cane, as once the rind is removed, it is as soft and juicy as Pattapatti, the standard chewing cane. It can be grown in all localities and can replace Pattapatti, Rasadali and Red Mauritius where they are still in cultivation.

Co. 419 : The total area under this cane, including the Factory zone, where it is the sole variety cultivated, is about 18,000 acres. It possesses great vigour and gives yields of 35-40 tons per acre. The extraction, though not so good as H.M. 320, is still fairly good being about 58 per cent. The jaggery is somewhat dark, but possesses good grain and hardness. It ratoons well and 2 ratoons can be taken with profit.

The chief drawback of this variety is that it flowers profusely under Mysore conditions and is therefore not suited for planting during the main season.

The variety is recommended to localities where ratoons are a standard feature of cane cultivation and for planting as an *adsali* (July-October) crop for which it is particularly suited.

H.M. 661 : This is one of the seedling canes evolved under the Indian Central Sugarcane Committee Sugarcane Breeding Scheme, at Bangalore and is noted for its great vigour and rich juice. Its performance has been tested in all parts of the State and it has given high yields everywhere. It yields 40-45 tons and ripens in about 12 months.

It is a medium thick cane which tillers profusely and arrows sparsely. Its fibre content is somewhat high but its extraction is as good as Co. 419. The quality of jaggery is also good.

It ratoons well and comes up well even under poor soil conditions. It is becoming popular in Bangalore and Mysore Districts and occupies at present 300 acres.

H.M. 647 : This is another improved cane noted for its erect habit, complete absence of lodging and very sparse flowering. It gives jaggery of an excellent quality. It is a thick cane with a moderate fibre content and ratoons well. It is becoming popular in Shimoga and Hassan Districts and occupies about 150 acres.

H.M. 645 : This is a thin or reedy cane of the *Cheni* type and has been introduced into cultivation in the *Cheni* area of the State. It tillers profusely and arrows sparsely and ratoons well.

The colour and quality of jaggery from this variety are excellent. It can be recommended with confidence in the areas where *Cheni* type of cane is being grown.

The area under this variety is estimated at about 400 acres mainly in the Chennarayapatna and Krishnarajpet Taluks.

I.C. 8 : This is also a medium thick cane, suitable for *Cheni* areas. It gives a good quality jaggery and ratoons well.

I.C. 26 : A thick cane with vigorous habit and non-flowering or sparsely flowering. This variety is doing well in Belur where at present it occupies about 50 acres. It yields 40-45 tons per acre and gives a jaggery of good colour and hardness. It ratoons well.

### Improved Varieties Ready for Release

In addition to the above, the following high-yielding varieties are ready for release and limited quantities of seed setts can be supplied to interested cane cultivators for trial planting on their lands.

I.C. 136 : An early variety ripening in about 10-11 months. Yields 35-40 tons per acre. Good jaggery type.

Co. 417 : A Coimbatore cane, late maturing (14-15 months). Good for jaggery making. Yields 40-45 tons per acre.

I.C. 201 : A thick cane, maturing in about 11 months. Gives good jaggery. Yields 40-45 tons per acre.

I.C. 203 : Similar to I.C. 201 in habit and yield but ripens in about 13 months.

I.C. 206 : A soft cane, non-flowering and ripening in about 13 months. Gives good jaggery. Extraction 60-65 per cent. Can be recommended in place of Pattapatti and Rasadali.

I.C. 219 : A medium cane which tillers profusely and arrows sparsely ; non-lodging ; cane somewhat short but yield quite good being 40-45 tons per acre. Gives jaggery of excellent quality.

I.C. 225 : A medium thick cane, sparsely flowering and early ripening (10-11 months). Yields upto 50 tons and gives jaggery of good quality.

I.C. 215 : A thick cane of the Co. 419 type, sparsely flowering and gives yields upto 50 tons per acre. Very vigorous and non-lodging in habit. Gives a good extraction (60 per cent.) and the jaggery produced is of good quality. It is a late maturing type, ripening in about 14 months.

Co. 636 : One of the recent batch of Coimbatore canes. Gives a good yield (40-45 tons per acre) but rather hard. It can be tried in *Cheni* area.

Quite a large number of canes, both Coimbatore and Mysore seedling canes, are being tested every year, and efforts are being made to introduce into cultivation the best among the varieties so tested.

The authors wish to express their grateful thanks to Dr. S. V. Govindarajan, Agricultural Chemist, and Dr. M. Puttarudriah, Government Joint Entomologist, for their kind scrutiny of the manuscript and useful suggestions.

The recommendations made above are based mostly on results of experiments carried out under the Sugarcane Scheme, financed partly by the Indian Central Sugarcane Committee, to whom our grateful acknowledgments are due.

# IMPORTANCE OF INSECTS IN AGRICULTURE

/ Dr. M. Puttarudriah, B.Sc. (Hons.), M.S., Ph.D. (Calif.)

Among insects there are numerous friends which are beneficial to man's advantage. The curious facts of honey production, silk production, shellack production, cross-pollination of flowers, work of beneficial parasites and predators, etc., will indicate how this humble class of animals contribute to world's commerce by millions of rupees and to the many comforts and luxuries of man. But the object of this paper is to point out the destructive nature of insects and to emphasize the urgent need for crop protection against insect pests ; and to practice it as one of the regular and important agricultural operations in the cultivation of every crop.

"It is remarkable that no cultivated crop is free from insect enemies. Practically every crop is subject to the attack of a score or more depredators and a few are the hosts of legions. Every part of the growing plant as well as the harvested fruit, seeds, and even the products manufactured therefrom are subject to infestation and to partial or complete destruction." Many insects are omnivorous feeders and attack a great and extensive variety of crops. With the change of environment, many minor insects become major pests and prove to be more destructive than the older ones. Insect pests have increased in abundance and destructiveness ; their attacks being more regular and constant. "They are injurious to crops in a variety of ways :— by chewing the foliage, stem, bark or fruit of the plant ; by sucking the sap of the plant ; by boring or tunnelling in fruits, stems, or leaves ; by attacking the roots or underground stems ; by carrying organisms of plant diseases (fungi, bacteria)" and by many other ways. They also destroy stored products, food, clothing, drugs, paper, books, furniture, buildings and timber, etc. Thus our crops have to struggle against the insect attack, from the time the seed is sown, till the time of harvest ; and even after harvest.

Several instances of insect havoc of major importance may be cited. Seeds sown are carried away by ants or otherwise affected by certain subterranean insects so that many a time necessity arises for resowing the fields. Cutworms are a serious menace to seedlings of kar ragi, pulses, cotton, tobacco, coffee and tea ; and soil grubs to paddy, jola and sugarcane and most vegetables and fruit crops. Stem borers tunnel in paddy, ragi, jola, sugarcane and several fruit plants and destroy them. The grown-up crop is attacked by grasshoppers, beetles and bugs of different kinds in both their younger and adult stages. In

recent years, the menace to paddy in Shimoga and other districts by the paddy grasshopper has been serious and widespread. Leptispa, a minor pest, had assumed a serious proportion in 1946, in the paddy areas of Malnad Districts. The staple millets like ragi and jola sustain heavy losses by the earhead pests in Mysore District. Of the earhead pests, the webbing caterpillar which destroys earheads both in the field and in stacks was found to be spreading in Hassan and Mandya Districts on ragi. The Deccan wingless grasshopper, on jola in Chitaldrug and Shimoga Districts, the sugarcane borers in the Mandya tract and the coffee borer in the Malnad areas are some of the other major pests of Mysore State. Among the pests of stored grains the grain weevil, the paddy moth, the pulse beetles and flour moth are more important ; and the damage and destruction they cause are no less serious. Thus all these several pests of field crops and stored grains levy a very heavy toll on the agricultural resources of man.

Man could have been certainly much better off, were all his insect enemies possible to be destroyed. We can only conjecture at the estimates of the loss incurred on account of the activities of injurious insects. The total value of the several crops in Mysore is estimated to be about Rs. 73,61,42,294. The average estimated annual loss caused by insects, the country over, is 10 per cent. of each crop. The estimate varies greatly from crop to crop in different places and among the different species of insects. It is found that more than 20 per cent. of the crop and its produce is destroyed in some places on this score. Expressed in terms of money, they look very impressive, especially when calculated at local scarcity prices. At a flat rate of 10 per cent. loss, it may be estimated that in terms of money value Rs. 7,36,14,229·4 worth of crop is being destroyed. The loss would be enormous if the loss caused by rats, bandicoots and other animals and plant diseases and weeds is added to that caused by insects. It is almost certainly true to say that the amount of food now destroyed in field and storage by pests controllable on present knowledge would amply supply the world's present food deficit. Further, the insect pests are ever on the increase, their multiplication being facilitated by the existence of crops during all seasons and in vast acreages under "Grow More Food Campaign".

The Division of Entomology of the Mysore Department of Agriculture is concerned since about 42 years with the insect problems. The task of the entomologist is very arduous. The insect problems are acute and difficult. He has been struggling hard against insects for the good of the cultivator. "In a struggle something akin to destroying ducks in a shooting gallery, the scientists have been knocking down one target only to find another coming steadily behind to take

its place. If they stop shooting, they find a whole row travelling serenely along before them. And perhaps most disheartening of all, they have found that a target knocked down once can return again in another cycle, strong and sturdy as ever." In formulating control measures against insect pests, the entomologist has got to study the biology and ecology of the pest, and take into consideration the poverty of the cultivator, the economics of the control measures and the results thereof, condition of the crops, possibility or otherwise of the control measures, etc. Before his results of research are taken to the cultivator, he has got to test them in the laboratory as well as in the fields under varying ecological conditions, to find out the efficacy of the measures. With these difficulties it is not so easy for him to hit upon easy and effective measures.

Even so, there have been many major accomplishments to the credit of the Division of Entomology. Several of the control measures are original and recommended for the first time by this Division. Collection of the moths of the red-headed hairy caterpillars by village children to prevent the outbreak ; kerosene treatment against paddy caseworm, hispa and leptispa ; breaking off the twigs in time by a forked stick to control citrus borer ; dusting the bunds with sodium silicofluoride against paddy and jola grasshopper nymphs ; spraying calcium arsenate mixture against potato Epilachna, etc., etc., have all been original control measures recommended by this Division. As a result of detailed researches in vegetable fish poisons to make use of the toxic properties against insect pests, the stem and root bark powder of *Mundulea suberosa* was found to be a good preservative of stored pulses against pulse beetles. Mercury was for the first time tested and found to be a good store preservative. Honge oil resin soap from the seeds of *Pongamia glabra,* now being manufactured by the Government Soap Factory, at the instance of, and as a result of research in this Division, has been found to be a good contact insecticide against greenbugs and other sucking insects. *Derris elliptica,* an insecticidal plant of great value, was imported by this Division for the first time from Java and is very well established in the State. Modern insecticides like D.D.T. and benzene hexachloride and many others have been tested and found effective on mangohoppers, ragi stem borer, grasshoppers and other major insects. In the field of biological control, this Division has been the pioneer in making use of the egg parasite, *Trichogramma minutum* Riley, against sugarcane borer. A laboratory for mass rearing of this parasite has been established in Mandya—the largest sugarcane tract in the State. The Cochineal insect imported into India for the first time by this Division in 1927, from Ceylon, has been remarkable in destroying the prickly pear, as

a result of which large areas originally covered by this weed are now free for cultivation. Useful investigations are being conducted with many other parasites and predators against insect pests. Mention may be made of the recent discovery of *Cryptolæmus montouzieri* Muls., and other predator beetles well known for their destructiveness against mealy bugs and aphids.

Many of the control measures have been found to be very easy and effective. They have been demonstrated many times to the cultivators in their own fields, employing the cultivators themselves for help, so that the measures and methods become familiar to them. In recent times, with great efforts, this Division has worked out other problems and standardised methods of greatly reducing the loss, by controlling in time the paddy grasshopper, jola earhead pests, ragi webbing caterpillar, paddy caseworm and leptispa, potato epilachna, sugarcane borers, store pests, etc., etc.

Recently, the Government have appointed plant protection staff working under the Assistant Directors of Agriculture in each district to render immediate help to the cultivator, against the common insect pests. It is very necessary that the cultivators should approach them for immediate help ; the Entomology Division being now more concerned with research work regarding more efficient and cheaper control measures, and studies with new pests.

In conclusion, it may be stated that "the war between man and insects has been endless and relentless ; still man has not gained any victory over his enemies excepting for a truce or a treaty or a partnership, as with bees and silkworm. But wherever their interests are diametrically opposed, the war goes on and neither side can claim a final victory. Insects are better equipped in this struggle, having been on earth for 50 million years, while the human race is but 500,000 years old". They are better able to compete with man by their size, prolific reproduction, adaptability, persistence and exoskeleton. So they have a better possession of the field than the man. Therefore, the entomologists should continue their researches for evolving better and easier methods of control; and the cultivators, the use of insecticides. But, in spite of the earnest efforts of the Division of Entomology in evolving cheaper, fool-proof and efficient control measures, and in demonstrating them hundreds of times, the cultivators have remained largely indifferent. Either they take the pests as ordained by God, or report very late when the question of food procurement comes up. The little attention paid by a few people if it concerns cash crops or when food procurement comes up, is not commensurate with the gravity of the pest control. The entomological workers have to limit their activities so far as to study the insects in

order to find out the vulnerable stage and hit upon easier and effective control measures and to demonstrate them. After this, the problem of reducing the world's loss of food crops due to pests, diseases and weeds no longer remains within the province of the specialist. It is a matter of vital concern to every intelligent student of current affairs.

It is very necessary that the cultivators should adopt such measures as regular agricultural practices just as they take care of ploughing, weeding, irrigation and harvesting in time without being told. They must be on the lookout for pests on their crops and immediately report and approach the plant protection staff or any of the agricultural officers for immediate help and take up control measures. It is earnestly hoped that even the influential men in the villages would enlighten and urge the cultivators to avail themselves of the help from the Department and protect their crops. All such co-ordinated efforts will go a long way in realising the object of "Grow More Food Campaign", and in solving the food crisis, and attain self-sufficiency.

*References*

1. *Destructive and Useful Insects.* (McGraw-Hill Book Co., N.Y.), 1939. Pp. 981.
2. *Agriculture in Mysore.* (Superintendent, Government Press, Bangalore), 1939. Pp. 214.
3. *A Syllabus for Economic Entomology.* (Univ. Calif. Berkeley), 1948. Pp. 33.
4. "Stationed to Serve", *Better Living Through Agricultural Research—Battling the Insects.* (*50th Anniversary* 1950-51, Pp. 60. Agr. Expt. Stn., Univ. Hawaii, Honolulu, Hawaii), 1951. Pp. 27-29.
5. *International Conference on Some Crop Production Problems in World Agriculture.* (Plant Protection, Ltd., 61, Curzon Street, London W.I., England), 1952. Pp. 116.

# POTATO CULTIVATION IN MYSORE

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There are two seasons in Mysore for growing potato. Although the crops may be raised in all the months of the year in Mysore, the potato thrives well if planted in the month of November (summer crop), and in the first and second week of June (monsoon crop). This crop prefers a sort of mild weather and cool atmosphere of rich humidity. No other food crop can produce as much of starch as this does in spite of this crop having a short duration of life-time. It may perhaps be due to its prohibitive cost that potato is not as important a food item with us as it can possibly be. Yields can certainly be increased to overcome this objection. To this end there is considerable necessity for research ; and speaking of our province, an experimental station round about Bangalore where the climate seems to be fit for this work can confidently be expected to help matters greatly.

The soil suitable for growing this crop is deep red loamy. Many people in Mysore take two crops in a year on the same land ; as one conducive to lowering of yields and spread of diseases and pests, this practice requires to be scrutinised. Potato responds well to rotation with ragi or onions and to a preceding crop of green manure.

The land has to be dug to a depth of 1½' 3-4 months prior to planting and weeds must be removed carefully. Then the dug up soil should be left over for a fortnight to weather. About 80-100 cartloads, *i.e.*, nearly 30-40 tons of farmyard manure and 800 lb. of bonemeal should be stirred into the soil to a depth of 6". Green manure seeds, either sunhemp or cowpea or horsegram or a mixture of all these may be sown while mixing the above manures in the soil. After 40 days from the date of sowing of this green manure crop, the land may be ploughed or dug so that the entire green manure is burried under the soil. After this operation, the soil has to be left over undisturbed for a period of one month so that the green manure may be sufficiently incorporated in the soil. Afterwards, a light digging to a depth of 1' should be given, levelling the field to facilitate easy irrigation. By working the soil 3 times like this, the field will be freed from weeds ; and the soil will be in a condition to give a good start to young potato plants after germination. Manuring the field just prior to planting as is generally done, does not seem to be helpful to the plants in the early stages up to one month. As this crop has a life-period of

only 3 months, this is an important point for consideration. Unlike other food crops, the potato plant manufactures and stores food materials in the form of tubers, *i.e.,* underground portion of the swollen stem right from the time of germination ; therefore, neglect in the early period of the plant is likely to lessen the chances of a bumper harvest. As such, giving a good start to the plants right from the germination is a good policy.

### Selection and Preparation of the Seed

There are many varieties grown in India ; and it may not be wrong to say that much work has to be done in evolving suitable varieties to the different places. Especially in Mysore, where the crop has a promising future, the need for establishing an experimental station to evolve suitable varieties from the point of view of disease-resistance, shape and size, baking quality, colour, duration of the crop and yield is being keenly felt. We generally import seeds from Simla for planting in November. The varieties and the origin of the mother-crop are not known to us unless we make special efforts to get the seeds from Government Experimental Stations and other Government agencies. Therefore, the stock obtained in bulk may at times fail to yield good produce. Selecting the seed by knowing the history of the mother-crop for disease-resistance, etc., will greatly enhance the chances of a successful bumper crop.

The eyebuds of potato tubers begin to sprout two months after the date of harvest and will then be fit for planting. Only potatoes preserved in a healthy condition are fit for planting. The seed should be preserved in such a condition as to prevent the attack of potato moths which usually lay eggs on the tubers and the caterpillars emerging out of these eggs begin to bore holes and destroy the tubers. Therefore, it is better if the seeds are preserved in soil mixed with gemaxine, a specific which is used to prevent insect attack. The seed potatoes should be preserved in an airy, cool and semi-dark room interlayered with a mixture of red earth and sand mixed with gemaxine and wood ash in proportion of 1 lb. to half-a-cartload of soil.

The seed-rate of potato varies according to the methods of planting. There are different types of planting practised in Mysore. In some parts of Hassan District, whole tubers are planted, whereas in Bangalore and Kolar Districts, the tubers are cut into setts so as to have two or three eyebeds for each sett. The planting space in the field also varies. In the case of a rainfed crop, where bullock power is employed for intercultural operations, the spacing varies from 1¾-2′ from row to row. In irrigated tracts where potatoes are grown under intensive cultivation, the spacing is 1-1¼′ from row to row. It is also seen that the setts are planted giving a space of not more

than 6" in the furrow in the above cases. The writer feels that the best spacing in any kind of cultivation is about 1½-1¾' from row to row and 9"-1' from sett to sett in a row. This affords facility for clean cultivation, good earthing up and an even distribution of plants in the field conducive to maximum harvest.

It is advantageous to cut the tubers into setts for planting, because diseased tubers can be eliminated. The planting of whole tubers gives rise to too many plants, *i.e.,* more than 6 plants at a place and these clusters may not develop good-sized tubers on account of keen competition for space underground. By planting setts which have only 2-3 eyebuds give rise to just 2 or 3 plants in each place and thus there will be a good scope for formation of big-sized tubers. The seed-rate in the case of planting whole tubers varies between 1,000-1,200 lb. per acre depending upon the size of the tubers. The seed-rate in the case of cut tubers varies between 800-900 lb. per acre. By careful selection, preparation and planting, it is possible to raise at least 55,000-60,000 plants in an acre by giving 1½' spacing from row to row and 9"-1' from plant to plant in the row. It is not an exaggeration to say that it is possible to harvest at least 60,000 lb. of potatoes by judicious cultivation. In the personal experience of the writer during the recent harvest in his field where an estimated yield of 53,440 lb. per acre was obtained, it was seen that individual plants yielded nearly 2-3 lb. of tubers per plant.

Tubers should be prepared for planting. Plants of various sizes are commonly noticed in potato fields ; this is mostly due to want of uniform germination. This defect is due to the fact that the eyebuds on the surface of the tubers will not have had uniform sprouting before planting. The following method may be tried. Spread tubers on moist bed of soil to a thickness of ½', spread over this semi-moist soil having a good proportion of sand in it so as to cover the potato layer with 3" of soil. Place over this a layer of green leaves, preferably *honge, tumbe* or *lantana* to a thickness of ½' to create sufficient warmth underneath. Remove the leaves after 72 hours and examine the potatoes for sprouting. If necessary, cover the tubers for another 24-48 hours, if the sproutings are not uniform. If necessary, give light watering by means of a water can to keep up uniform semi-moist condition throughout this process. See that care is taken to prevent rain water falling on this bed. This process is seen to assure uniform sprouting and the setts cut out of these tubers are found to give a uniform germination and stand of the subsequent crop in the field. Unsprouted setts may be sorted out in the above process treating them further for germination. It is found that setts treated as above are not spoiled after planting in case of heavy rains immediately after planting.

## Planting

The seed-bed for planting should be semi-wet and the furrows should be opened across the slope of the field having a space of 1½′ from one another. A special implement to open two furrows at a time at a distance of 1½′ has been devised in the writer's factory at Nelamangala. Irrigation channels preferably 6′ apart may be opened across the furrows so as to divide the whole field into small plots of not more than 2 guntas (1/20 acre) each, in order to secure a uniform spread of water while irrigation is given. It should be borne in mind that the soil should have optimum moisture condition while opening the furrows and also when planting. Then the setts are planted at 9″-1′ apart in the furrows burying them about 1-1½″ deep in the loose earth. A top-dressing of potato manure mixture consisting of ammonium sulphate, superphosphate and potassium sulphate may be given just after planting and before first irrigation. It is found by experience that this mixture can conveniently be applied if it is mixed with a good quantity of well powdered compost. It may be applied before planting also, provided the placement of the manure is not disturbed while planting and touching up levels after planting. On the writer's farm 4 cwt. of this mixture consisting of 1½ cwt. of ammonium sulphate, 1½ cwt. of superphosphate and 1 cwt. of potassium sulphate was mixed with 10 cartloads of well powdered farmyard manure which was sufficient enough to cover an acre of land at the rate of 1 lb. per furrow of 6′ in length. The field should not be irrigated at least for 2 days after planting. Any heavy rains within 5 days after planting in the case of this treatment on wet soil previous to planting, will completely spoil the germination when unprepared setts are planted. In rainy season it is better if the setts are planted in the middle of the slope of the ridge of the furrow. This will save the setts from water stagnation in case of heavy rains. While cutting the tubers for planting care has to be taken to discard tubers affected by ring disease and to disinfect the knife by dipping it in potassium permanganate solution for further use.

## Care and Cultivation

As said already, the life-span of potato plants is very short when compared to the huge quantity of starch material stored in the form of tubers. One has to see that the crop takes a good start right from the germination so that no setback in growth is caused at any stage either by irrigation or by delaying other operations like weeding, mulching, spraying and earthing up. A preliminary weeding has to be attended at the third week from the date of planting. If there are no rains, the plot should be irrigated regularly once in 4 days up to a period of one month. Care has to be taken to see that the water does

not stagnate in the furrow for more than 15 minutes in case of heavy rains. In case of clayey soils likely to be water-logged, good drainage has to be provided to keep the soil under optimum moisture conditions. While weeding the plot employing manual labour, the weeders generally trample the field and damage the loose structure of the soil. The weeding tools have pointed ends and a serious mistake is committed by the weeders when they try to remove weeds within a range of 3-4" around the plant. By careful observation, it is found while piercing these tools for purpose of removing weeds around the plant they unconsciously prick and disconnect the young primary potato-forming tender underground shoots. Thus invariably they disconnect the young first-formed tubers. Potato plants, by habit, simultaneously send these tuber-forming roots as the growing germ appears above ground. These shoots, to begin with, will be very tender and very near to the surface of the soil. This weeding sickle if pierced around the plant will easily disconnect the tendered tubers resulting in the wastage of the energy of the plants and limiting the lifetime of the plant for producing the fresh tubers. At a stage of nearly one month in the life of the plant, if the first-formed tubers are disconnected by this operation, there is not much time or scope for the plant to develop full-sized tubers in subsequent formations. The very first pick of the yield goes off unnoticed by this mistake which is done unconsciously. By avoiding this mistake the potato cultivators can double their harvest. Therefore the weeding tool should not be taken within a range of 2-4" around the stem. A special implement is devised in the writer's factory for the purpose of removing the weeds and making a mulch. This implement has been used successfully along the furrows and will lessen the trampling in the field. If this implement is used carefully, it will successfully remove the weeds and also leave the soil with a good loose mulch. Any weeds left over between the plants where the implement does not touch (*i.e.*, in the above prohibited range), the same may be removed by handpicking at the time of irrigation without using any tool.

Alternaria or early blight and pests like aphies and caterpillars of epilachna beetle at the fourth week of the crop are the common enemies of our potato crops. A preventative spraying has to be done taking care to see that the sprayed material is applied uniformly to cover both the lower and top surfaces of the folliage and the stem. There are a number of fungicides available in the market of which the writer has used the following mixture successfully ; 10 gallons of 1 per cent. Bordeaux mixture with 1 lb. of calcium arsenate and ½ lb. of *honge* oil soap thoroughly mixed and sprayed to cover an area of 10 guntas. Plants from tubers affected by ring disease begin to wilt at this stage. These plants are to be pulled out and the soil around the roots of these also removed and burnt. The pits formed in such

places should be disinfected by applying a solution of lime or copper sulphate or potassium permanganate. If this is not done, the soil carries infection to the subsequent crop, thereby rendering the field permanently unfit for planting potatoes.

At this stage, *i.e.,* about the fourth week, the crop is ready for earthing up. A preliminary scraping of the ridges is done by an implement devised for this purpose. A ridger is also devised for the purpose of earthing up to minimise labour and enhance efficiency. If this operation is done by manual labour by using hand *guddalies,* the writer is of opinion that the field will be trampled and the soil hardened, damage being caused to the tender tubers. This earthing up provides a heap of loose earth on either side of the stem of the plant at the zone where the first- and the subsequent-formed tubers develop and also induces the plants to strike fresh tubers. Care must be taken to see that this loose texture of the earthed-up ridge is maintained to the very end.

The present practice of irrigating the field 3 days after the earthing up is detrimental to the formation and development of the tubers. The disturbance of the soil by this operation will also disturb the root system of the plant to a certain extent. Cultivators believe that the slight suffering of the crop evidenced by light withering of the foliage is beneficial to the crop, if it is irrigated 3-4 days after earthing up. In case of ragi and other cereal crops, this sort of delayed irrigation after the disturbance of the root system is really beneficial because it encourages formation of fresh roots and tillerings which will put up fresh vigour in the growth so as to help forming good earheads in the latter stages of the crop. In the case of potato it is to be borne in mind that the plants commence forming tubers from the time of germination and the disturbance of the root system will check the development of the tubers. Delayed irrigation will temporarily check the growth of the plant and as the writer feels the plants take at least a week to recoup this loss. Therefore, irrigation must be given right on the day following the earthing up operation.

The cultivators generally top-dress the crop just prior to earthing with potato fertilizer or oilcake or farmyard manure or a mixture of the above. The writer feels that this will not be helpful to the plants in enhancing the yield. In view of the manurial doses given in earlier stages as suggested the soil placed around the plants while earthing up is done is likely to be sufficiently rich in available plant food materials.

Subsequent irrigations depending upon the retentive capacity of the soil and rainfall conditions will ensure the cultivator with a bumper harvest of not less than 55,000-60,000 lb. of potatoes per acre. The

next precautionary measure to be adopted at the end of the second month is to repeat spraying. Irrigations should be given more frequently, preferably once in 3 days or on alternate days during the third month, because the area of folliage increases and transpiration is more in that duration of the crop.

The crop begins to change its colour from dark glazy green to lighter shades of green mixed with semi-ripe orange. It will be ripe for harvest between the twelfth and the fourteenth week from planting depending upon the locality, season, treatment and other conditions like spraying, manuring, etc. The signs of maturity of fully grown-up tubers can be judged by tapping the tubers with the finger tip. An unmatured potato gives a soft watery and flat sound, whereas the fully matured potato gives a hard sound. The harvest should be left in the field for about 10-12 hours before it is handled for grading and storing.

The writer does not believe in the fact that potato cultivation is a gambling affair as is commonly expressed by cultivators. This crop will not betray an earnest effort.

The following estimate of expenditure on, and income from, potatoes pertains to the crop recently raised on the writer's farm :—

Date of planting : 22 Nov. 1952.
Date of harvest : 22 Feb. 1953.

Cost of Cultivation

| | Rs. | A. | P. |
|---|---|---|---|
| 40 md. seeds of 28 lb. .. .. .. | 300 | 0 | 0 |
| 30 md. bonemeal .. .. .. | 100 | 0 | 0 |
| 4 cwt. potash mixture .. .. .. | 64 | 0 | 0 |
| 100 cartloads manure .. .. .. | 350 | 0 | 0 |
| Digging I & II .. .. .. | 240 | 0 | 0 |
| Planting, manuring, etc. .. .. | 95 | 0 | 0 |
| Irrigation and earthing up .. .. | 75 | 0 | 0 |
| Spraying .. .. .. .. | 45 | 0 | 0 |
| Harvest .. .. .. .. | 26 | 0 | 0 |
| Total cost .. .. .. .. | 1,295 | 0 | 0 |
| Yield : 1,900 md. at Rs. 5-0-0 .. .. | 9,500 | 0 | 0 |

# DISEASES OF FODDER CROPS IN INDIA*
## III. GRASSES AND OTHER FODDERS

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[Many farms in India have taken up to grasses as one of the major fodder crops. They are becoming specific in the crop rotation programme in the farm, pastures and in the range. Grasses of many different varieties and species are grown in our farms. So much so it is very difficult to set a hard and fast rule as to their susceptibility to the various diseases. For instance, amongst the many species one of them might be susceptible to a particular disease, while another might not be attacked at all. Under these circumstances, diseases become a more evident factor in the development of economy of the selected strain that needs be grown.

In this article is also included diseases of other major crops grown in some places as fodder crops, like the crops that belong to the family Leguminoseæ.]

### A. Grasses

Grasses, during their growth, vary in their susceptibility to diseases during the various stages of growth. Thus, its variation can be seen when the crop is susceptible to disease in the nursery while in the pastures it is not. So, control methods vary differently under these different conditions of growth. Under these circumstances, in this particular article we will have to list only the symptoms, the morphology of the parasites, and in general, etiology and the control of these diseases.

Grasses are subjected to more of fungal diseases than others. Other diseases that are quite common are the non-parasitic maladies like chlorosis, leaf-flecking, etc., virus diseases like the mosaics and also some bacterial diseases.

(*a*) *Non-parasitic maladies* such as chlorosis and leaf-flecking or spotting occur owing to unfavourable conditions in the soil and the environment. Mineral deficiencies are also known to cause the above maladies.

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This article is the last of the series appearing under *Diseases of Fodder Crops in India.*

The author also wishes to thank all his colleagues who evinced interest in the preparation of these articles.

When inbreeding is employed in the breeding programme, pigmented spots occur on the leaves of many species, such as those of *Andropogon, Bromus, Dactylis, Panicum* and *Sorghum.*

(*b*) *Virus Mosaic Diseases.*—Two mosaic complexes occur on the grasses. The grass mosaic complex which is also prevalent on the sugarcane, corn and other related grasses is common on the grasses of the warmer climates. Mottling, chlorosis and striping are similar to those occurring on the sugarcane and corn. On *Bromus inermis,* the wheat mosaic occurs, in some parts of the United States and some parts of Russia also. Some of the *Avena* sp. are also infected with the oat mosaic.

(*c*) *Bacterial Blights*

Causative organism : *Pseudomonas coronafaciens,* var. *atropurpureum.* (Reddy & Godkin)
*Xanthomonas translucens.*
(Jones, Johnson & Reddy).

Specialised varieties of the two common cereal bacterial pathogens occur on the grasses. *Psedomonas coronafaciens* causes a bacterial blight, which is widespread on species of many grasses. In particular, *Bromus inermis* and *Agropyron repens* are attacked most. The lesions that develop are at first circular to elliptical, water-soaked and these later coalesce to form purple brown areas on the leaf-blade and sheath. There is no exudate on the surface of the lesion. On the pedicles and the panicles spots are limited and restrained. Many grasses are susceptible to this disease. According to Allison and Chamberlain (1946), Reddy and Godkin (1923) and others this disease occurs on *Agropyron, Bromus, Elymus, Lolium* and *Phleum* sp., and other genera. On certain species of *Agropyron, Bromus* and *Hordeum, Xanthomonas translucens* causes an irregular brown lesion or stripe with an exudate on the surface of the leaves. Also the bacterial blights or sorghum and sugarcane occur on the related grasses. The more prevalent of this type is the bacterial stripe and streak of the Johnson grass.

(*d*) *Diseases Caused by the Fungi*

As mentioned before, grasses are attacked by a number of fungal parasites. A mention is made here about a few of the most important diseases.

(1) *Pythium Seedling Blight and Root Rot*

Causative fungus : *Pythium* sp.

Sprague in 1944 reviewed the severe damage caused to the grasses by Pythium, common on cereal crops. *Pythium arrhenomanes* and *Pythium graminicolum* are usually associated with the seedling blight and the root rots. The life-history of this fungus has been dealt in detail in the previous article on this subject.

The only known method of protection or control against this malady is by regulating crop sequence, soil fertility, soil preparation and the time of sowing.

(2) *Downy Mildews*

In India this disease is most common on *Pennisetum* and *Setaria.* According to Hiura (1935), this particular disease is very common on the grasses of the Asiatic countries. The causative fungus, namely *Sclerospora graminicola,* also attacks the sorghums. The control methods for the prevention of this disease is as for the sorghum for this particular disease. (Diseases of Fooder Crops—I. Sorghum.)

(3) *Powdery Mildews*

Causative fungus : *Erysiphe graminis.*

Powdery mildew is widely distributed on many genera of the grasses. This particular disease is more dangerous potentially in nurseries and seed fields than in pastures. The disease appears during cool, somewhat cloudy seasons, especially on the leave. This parasite is known to occur on both cereals, as well as the grasses since 1815. In 1902 people came to know that powdery mildew was at least composed of 7 varieties, each variety confined to a particular genus of the host. However, the symptoms and etiology are similar. The variety *Erysiphe graminis* var. *hordei* is more prevalent on both grasses as well as some of the cereals. On barley also it gives rise to the same symptoms.

*Symptoms.*—The signs of this disease are much more evident than the symptoms. The fungus under favourable conditions attacks the stems and also the glumes, but in general, it is limited to the leaves. The pathogen grows in numerous colonies on the upper and the lower surfaces of the leaves. At first these colonies appear like small, white, felty, circular masses of mycelium and spores. This white, floury mass can be scraped off, and the underlying leaf surface shows a normal leaf, only slightly injured. But as the mycelium ages, the hyphæ and spores ochre or brown and form a thick matted growth on the leaf. The leaf shows slight yellowing followed by the appearance of reddening round the colonies. An important point to be noted is that the mildew causes the plant to transpire more than the normal plant. Infected plants transpire 67 per cent. more water from equal leaf areas than plants not infected. As a result of the infection, a stunted growth of the plant and the necrosis of the leaf-tissues sets in, with the result that the plant gets completely defoliated.

Infection takes place when the young leaves in the cool, moist conditions are exposed to conidia. The heavily infected leaves die after 14-20 days. After dying, these leaves dry up and subsequently

infect another new leaf. This type of continued infection has its effect upon the formation of grains as it leads to premature heading and shrivelled small grains in the plant. Stem infections may also occur which, if severe, often weaken the plant, resulting in lodging the plant.

*Etiology.*—The disease is caused by a fungus *Erysiphe graminis*. The profuse external mycelium produce haustoria from small appressoria which develop on the hyphæ. These haustoria enter the epidermal cells of the host where they produce finger-like projections extending in the longitudinal direction of the cell. The hyphal cells of the epidermal, external mycelium produce conidiophores, consisting of a swollen basal cell, a sporogenous cell, two or three developing conidia, and a barrel-shaped mature conidium, which after being forcibly discharged becomes elliptical to spindle-shaped. These conidia germinate by the production of germ tubes. The conidia lose their viability gradually after separation from the conidiophores.

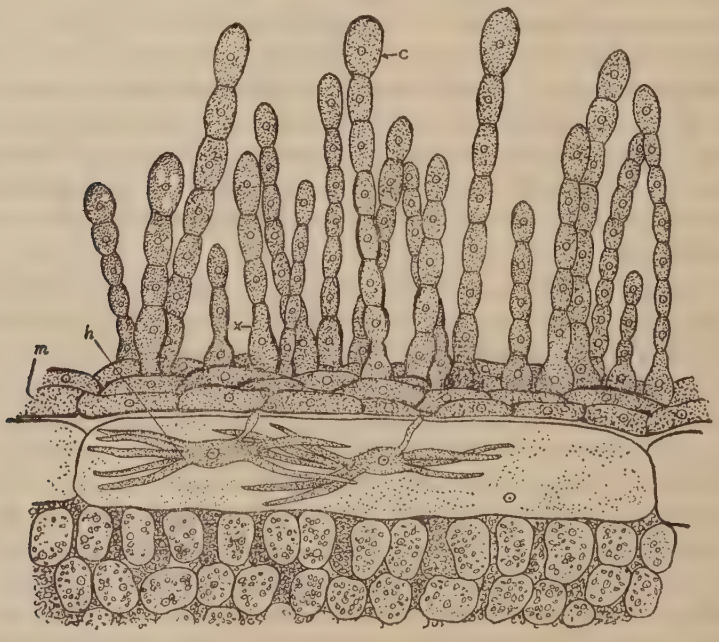


Fig. 1. *Erysiphe graminis* on a leaf of grass showing the mycelium, haustoria, conidiophores and conidia.

The optimum temperature for growth on a new substratum seems to be between 12-21° C. The germ tubes on touching the cuticle form the appressoria from which penetration tubes enter the epidermal cells. From these small penetration tubes are formed the first digitate haustoria. From the external germ tube arise the hyphæ which multiply

to form the mycelium. From this are developed the conidiophores and the conidia, which take about 2-3 days.

The fungus also reproduces sexually when spherical structures with hyphæ like appendages covered with sterile setæ, known as perithecia are formed, by the union of two adjoining hyphæ. These perithecia, however, need a period of rest before the ascospores could be liberated. This is the resting stage of the spore of the pathogen.

FIG. 2. Perithecium of *Erysiphe graminis* var. *hordei,* showing the nature of the appendages.

These perithecia now remain in the soil and after sometime the perithecium liberates ascospores which infect a new plant. Very little is known at present about the germination of the ascospores in the new host. One important point is that if the ascospores do not infect a new plant within 30 hours of their liberation, they die off.

*Control.*—Since the mildew is favoured by thick-seeding and high humidity, these conditions should be avoided. Sulphur applied as a dust is an effective fungicide, but the value of the crop and the cost of treatment make it impractical.

(4) *Ergot*

Causative fungus : *Claviceps* sp.

*Fusarium* sp.

It has been known since a long time that several species of *Claviceps* occur on the cereals and the grasses. The common ergot on the grass is caused by *Claviceps purpureæ.* This species occurs widely on cultivated as well as wild grasses. The disease reduces seed production in areas of high summer humidity and causes abortion, reduction in milk production and constriction of the capillaries when eaten in

quantities by the livestock, owing to the poisonous nature of the sclerotia of the pathogen.

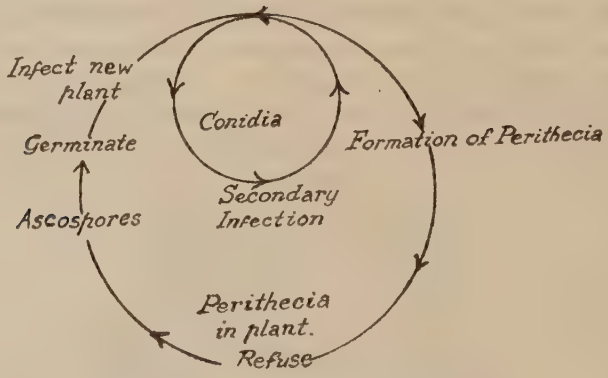


Fig. 3. Infection cycle of *Erysiphe graminis.*

The disease is of particular economic interest and importance owing to the high poisonous nature of the abovesaid sclerotia. It is, of course, this property that gives the disease its real significance, since the reduction of the crop is never great, rarely exceeding 5 per cent. In cereal crops ergot reduces the yield by replacing the seeds with the ergot sclerotia. But in medicine ergot occupies an important position, as it finds extensive use in causing constriction of the blood vascular system, thus preventing excessive bleeding.

*Symptoms.*—The most conspicuous and predominant symptoms in the field are the presence of honey dew oozing from the flowers and later on the appearance of the large, blue to black, curved, long sclerotia. Flowers are also blasted out due to the necrosis of the young pistil. But this is not so common. In the flower an yellowish white mass of mycelium develops in the ovary and from the infected ovary is exudated the sickly, sticky, yellowish and sweetish honey dew.

This honey dew disappears after sometime and then the ovary is replaced by the mycelium that becomes hard and horny, purple to black in colour. This is many times the normal size of a grain. This is the sclerotium. Its surface may be cracked and it may have at its tip a whitish, small brush.

*Etiology.*—The disease is caused by a fungus known as *Claviceps* sp. This pathogen has two stages in the formation of spores in its life-history. When the honey dew is examined microscopically, it shows the presence of numerous, unicelled, hyaline spores. These spores or the conidia are carried to other flowers by insects that visit the flowers attracted by the honey dew. On the stigma they germinate to form the hyphæ which grows down to infect the ovary. The stony ergot that replaces the seed is a horny mass of mycelium, the hyphæ

of which are in the resting stage and are thick-walled. This is known as the sclerotium. It passes the adverse conditions in the soil and germinate during spring time, when the flowers are usually open and infect the plant.

On germination, the sclerotia produce several erect slender stalks about ½" long on which are borne the perithecial stroma. These are at first yellow in colour, later turning to black. In the stroma are flask-shaped structures within which are the asci, containing the eight multiseptate, thread-like ascospores, which are discharged forcibly at maturity. These spores again rest on the open flowers and thus infect them. Warm, dry weather during the flowering season of the grasses, shortens their flowering period, thus rendering this climate unfavourable for the parasite to germinate and infect. On the contrary, a wet climate lengthens the flowering period, thus exposing the flowers and the plant to infection.

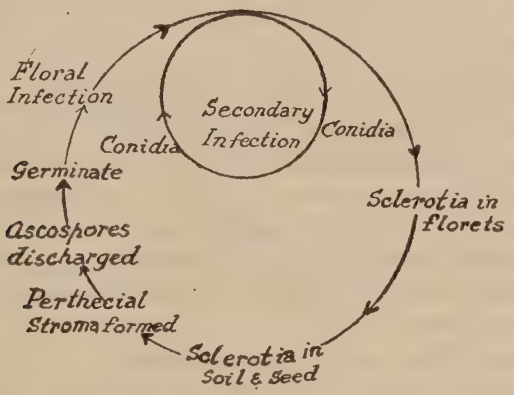


Fig. 4. Infection cycle of *Claviceps* sp.

The poisonous effect of ergot sclerotia is due to an alkaloid, which causes convulsions and gangrene. The important toxins have been named as *ergotoxin, ergotinin, cornutin* and *sphacelic acid.* The aforementioned alkaloid has the properties of adrenalin, the active principle being *p*-oxyphenylethylamin.

*Control.*—It is imperative that the susceptible hosts like the other grasses should be destroyed before the specific grass plants blossom. Rotation of crops is also beneficial. The seeds before sowing can be treated with some important commercial fungicide. The ergot present in the seeds can be removed by placing the seeds before sowing in a 30-32 per cent. sodium chloride solution. The ergot sclerotia have a lower specific gravity than the seeds and so they float on the top of the solution and thus they could be skimmed off. Following such treatment, the seeds should be washed and dried before sowing.

(5) *Epichlœ Head Blight or Choke*

Causative fungus : *Epichlœ typhina* (Fr.) *Tul.*

This disease has been reported to attack many varieties of grasses both in Europe and Asia (Sampson and Western, 1941). The fungal mycelium is formed over the crown buds of the infected plants. From here the infection spreads on to the primordial tissues. The mycelium in summer forms a felt-like covering over the tillers. In other words, the mycelium forms numerous white stroma with minute conidia over the inflorescence. As the plants approach maturity, the colour of the stroma changes to orange and numerous perithecia develop in the stroma. The asci in the perithecia contain 8 ascospores, which are discharged into the air, and these infect a new plant.

(6) *Seedling Blight and Crown Rot*

Causative fungi : *Gibberella zeæ* and *Fusarium* sp.

These two fungi have been known to cause this disease. But this disease is not so important on the grasses as compared to the disease on the cereals.

(7) *Helminthosporium Foot Rots and Leaf-Blights*

Causative fungus : *Helminthosporium sativum.*

Drechsler (1923, 1929, 1930, 1935), Henry (1924), Hynes (1937) ; Nishikado (1924), and Sprague (1944) have reported that nearly about 30 species of Helminthosporium occur on the grasses. But amongst all the species the most important is *Helminthosporium sativum* (Pamm, King and Bakke), attacking many of the grasses and the cereals alike.

*Symptoms.*—The most common symptoms are the appearance of spots on the leaves which are dark brown in colour. The individual lesions are round to oblong. Sometimes the spots coalesce together to form larger blotches of spots in scattered areas on the leaf.

*Etiology.*—The infection arises from the soil or from the seed-borne mycelium. The fungus produces a large number of conidia, which are shed from the projecting conidiophores (which come out from inside the leaf through the stomata) and these conidia infect a new plant. In most cases, the infection arises from the remains of the older crops that are left in the field after harvesting, which serve as the source of inoculum.

It is impossible to study the various species and their etiology owing to the fact that grasses are attacked by a large number of species of helminthosporium. The *control* methods can be roughly said to be as follows : (1) Since the fungus is distributed in the stubbles of old crops, it is always a safe method to clear the field off the remains of the older crops ; (2) Rotation of crops also helps

a good deal in the control programme of this disease ; (3) Also modification of the existing cultural practices so as to render the growth of the fungus unfavourable would also help quite a bit in eradication and the control of this disease.

(8) *Septoria Leaf Blotch*

Causative fungus : *Septoria* sp.

Numerous species of septoria attack the grasses throughout the temperate and the tropical zones of the world. The leaf blotches usually bring about the defoliation of the crop and also reduce the seed yield.

The pycnidia of the parasite are present in the older portions of the leaves. In the genus *Septoria,* the pycnidia are subepidermal, and are formed on the spots of the leaf, culm or the inflorescence. (Frandsen, 1943; Grove, 1935, 1937; and Sprague, 1944.) The globose- to lens-shaped pycnidia are coloured brown to black, parenchymatous, comprising of the outer layer of polygonal cells and the inner layer of hyaline cells which produce the conidiophores. The conidia that are produced are septate, hyaline, 10 times as long as broad, straight or curved. In the autumn, the conidia are biseptate, slender, whiplike and stouter. The infection is spread from the remains of infected plants and also infected seeds. Control of the disease is only by rotation of the crops and by general sanitation throughout the cultivation of the crop. Treatment of seeds before sowing with mercuric compounds might also help to kill the seed-borne fungus.

(9) *Leaf Smuts*

Causative fungi : *Ustilago* sp.
*Urocystis* sp.

Like the maize, the grasses are also susceptible to many varieties of smuts like the stripe smut, flag smut and the spot smut. The fungus that attacks the crop is almost similar to that which attacks maize, a description of which has already appeared (*Diseases of Fodder Crops in India,* Part II, Maize).

*Urocystis* sp. that causes the flag smut in the grasses is not so much known to attack the maize. This fungus manifests itself as a smut especially on the upper leaves of some groups of grasses. The spores of this fungi are spherical cellular masses called the spore balls. Only the central cell of each ball is fertile and capable of germination ; the others are sterile. Germination begins after 72-144 hours after the spores are brought into contact with the new host under favourable conditions. A promycelium develops from the central cell developing a whorl of branches. These branches might grow as mycelia.

The only best method of control is by treatment of the soil before sowing the seeds.

(10) *Stem Rusts*

Causative fungus : *Puccinia graminis.*

A large number of the species of the genus *Puccinia* attack the grasses. As already reported, the symptoms and the effects are the same as for other cereal as well as the fodder crops.

(11) *Anthracnose*

Causative fungus : *Colletrichium graminicolum.*

This particular disease occurs both on the grasses as well as other leguminous fodder crops, such as cowpeas, lucerne, berseem, etc. The disease is associated with conditions of low or unbalanced fertility of the soil, open coarse soil and continuous grass cereal culture. The disease becomes apparent as the crop approaches maturity.

*Symptoms.*—The apparent symptom commonly manifested is the reduction and loss of vigour of plants development. Premature ripening or drying may also indicate the onset of the malady. Then appears the mycelium, followed by the browning of the culm bases and the crown tissues. Another notable symptom is the development of black acervuli on the surface of the lower leaf-sheaths and culms.

*Etiology.*—The acervuli are superficial and are circular to oval. The dark mycelium forms the basal stroma. The setæ which are dark brown are formed through the conidial forming stroma which are septate and tapering at the apex. The conidia that are liberated are spindle-shaped, unicellular, hyaline and slightly curved. The pathogen is saprophytic on the remains of old crops which serve as a source of infection.

*Control* methods are by crop rotation and improvement of the soil fertility. Proper balance of potash and phosphorus greatly help in the reduction and eradication of the disease.

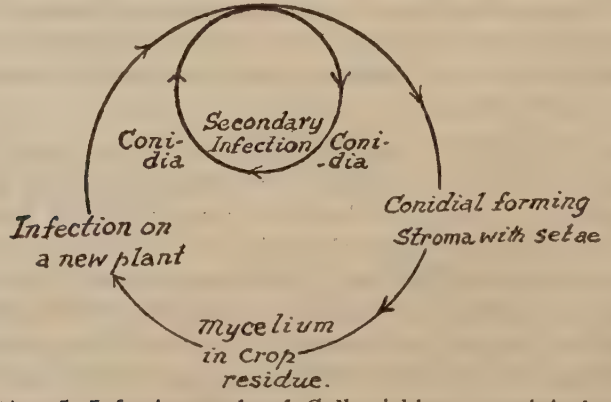


Fig. 5. Infection cycle of *Colletrichium graminicolum*

Many other diseases of minor importance have been known to occur on the grasses.

## B. Other Fodder Crops

Passing on to some other crops which are as important as the fodder crops, though cultivated in a small scale, we have to consider the crops belonging to the family Leguminoseæ, that are being cultivated in India. Amongst these, the most important ones are the cowpeas and the clovers, such as berseem and lucerne. These plants are also attacked by a variety of pathogens and it is well that we study a few of the important diseases of these plants.

I. *Cowpeas* (Kannada name—*Alsande*).

This crop is grown widely in India as a green fodder, hay, green manure and as a soil-improving cover crop. This plant is attacked by a large number of pathogens, the most important of them being, however, rust, powdery mildew, anthracnose and root rot.

(*a*) *Rust*

Causative fungus : *Euromyces appendiculatus.*

Much about the rust is not known in the sense it is not very clear. The rust attacks the plant causing considerable damage. The only method of control that is known is by growing resistant varieties. The American variety "Iron-cowpea" is said to be resistant to this disease.

(*b*) *Powdery Mildew*

Causative fungus : *Erysiphe polygoni.*

The powdery mildew has been one of the most dreaded diseases since a long time. Though the particular species that attacks the cowpeas is a different one, the life-history, symptoms and etiology are the same as those of the parasite on the grasses. Control methods are also the same.

(*c*) *Anthracnose*

The cowpeas is also attacked by the fungus that causes anthracnose in the grasses. There have been suggestions that possibly there might be a different fungus that attacks this crop. Some scientists have suggested that possibly *Clomerella cingulata* might be the fungus that attacks this particular crop. However, the etiology of the disease is similar to that on the grasses and the same control methods could be applied with advantage.

(*d*) *Root rot*

Causative fungus : *Rhizoctonia* sp.

Two types of root rots are known to occur in this crop. The violet root rot caused by *Rhizoctonia violaceæ* is the most common. The areas affected become brown with a matty covering of mycelium

in the early stages. Later on, the roots get rotted, shredded and coloured violet. The rotted portion nearly extends from the crown to about 6" below the soil. The other variety described by Smith in 1943 was a root cankering due to *Rhizoctonia solani.* The root is not rotted completely as in the former disease. The occurrence of dark sunken areas is limited to the tap root and its branches.

As the disease is limited and associated with the low areas subjected to flooding, this condition, if avoided, forms a very good control method.

These are, in short, the important diseases that attack the cowpeas.

II. *The Clovers* (namely, the lucerne and the barseem)

Amongst the other nutrient fodders, the clovers occupy a very important position. The lucerne or the alfalfa and the berseem are two of the most important crops that are grown widely in India for the sake of their fodder. These plants, like the other leguminous plants, are very good hosts to some very important diseases like the virus, bacterial and the fungal diseases in common.

(*a*) *Virus Diseases of the Clovers*

The mosaic type of virus in the clovers is spread by *Macrosiphum pisi.* This particular virus that attacks the clovers is widespread on a variety of hosts like the peas, potatoes, celery, etc.

The first symptoms are small, greenish, yellow spots on the leaf followed by chlorosis. The leaflets and the leaf become crinkled, irregular in shape, brittle and there is little or no necrosis of the tissues (Weimer, 1934). The virus is transmitted by an aphid to nearly 24 plants belonging to the family Leguminoseæ. The pea aphid is the most common and the natural vector.

Another type of virus disease is *The Witche's Broom,* transmitted by graftings as well as by an aphid *Scapytopius acutus.* This disease is not so common in India but widespread in Australia.

The berseem is subjected to other virus diseases, namely, the clover mosaic, ring spot and streak. Mosaic virus may be caused by any one of the pea, bean, alfalfa, mosaic viruses. A strain of tobacco ring spot virus produces veinal chlorosis and chlorotic ring in the case of berseem.

(*b*) *Bacterial Wilt*

Causative organism : *Corynbacterium insidosum.*

This disease has gained a wide importance in the fodder cultivation. Though spread over considerable areas over the world, it is of great importance in the United States of America and India due to

the great economic loss it causes. The plants are killed so rapidly that the land becomes unprofitable in 3-4 years.

*Symptoms.*—The notable symptoms are reduction in plant vigour, yellowing and bleaching of leaves, and ultimately death of the plants. On the infected plants, the leaflets are smaller and thicker than the normal leaves and the stems are smaller and more numerous in the earlier stages of disease development. Also the tap root shows a discolouration (pale brown) of the outer woody tissue. The bacteria are present in the xylem bundles of new growth and spread on to the parenchymatous tissue and the adjacent bundles thus distributing itself along the circumference of the root.

*Etiology.*—The bacteria in the older diseased plants are released by the breaking down of diseased tissues and the bacteria get distributed is the soil water. New plants with injuries on the roots get infected. The infected plants usually die off during the later part of the summer in the second year.

*Control* is only possible by the cultivation of resistant varieties of crop being used. It has been suggestel that the Turkestan varieties of the clovers are immune to this disease.

(*c*) *Phythium Dampling Off and the Root Rot*

Causative fungus : *Phythium* sp.

The disease is akin to the disease caused in maize. The etiology and the control of the parasite are by the same methods as used for the infection in the maize.

(*d*) *Downy Mildew*

Causative fungus : *Perenospora trifoliorum.*

Downy mildew occurs widely on lucerne, throughout the temperate zones in the world. Berseem is also susceptible to this disease to a certain extent.

*Symptoms* as noticed in the early stages are the growth of light green leaves at the apex of the stem and the development of grayish white mycelium on the surface of the leaves. The conidiophores and the conidia are conspicuous on the lower side of the leaves and the leaflets. Conidial production becomes abundant just prior to the collapse of the leaf-tissue. Oospores are also produced in the leaf-tissue.

*Etiology.*—The mycelium is abundant in the leaf- and stem-tissues. The conidiophores which are slender, dichotomously branched, with secondary branches curving downwards in the older conidiophores, produce elliptical, violet-coloured conidia which germinate on a new host by the production of a germ tube. The oospores are globose, and light brown with a smooth wall. When once the parasite gets established, it is difficult to remove the same due to the oospores in the dead

tissues in the soil and the perennial mycelium in the crown tissues. Secondary infection spreads by conidia wherever and whenever the conditions are favourable.

*Control.*—Clonal lines of lucerne show differences in susceptibility. So, embodying this principle, resistant varieties could be grown.

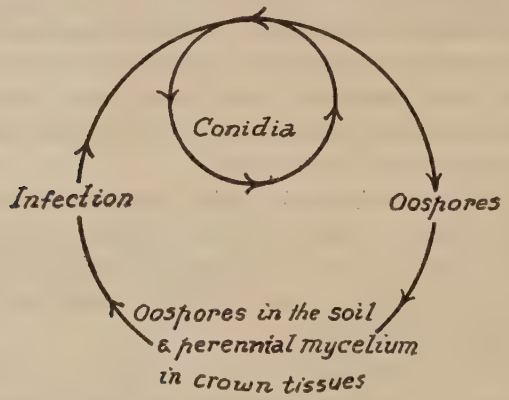


FIG. 6. Infection cycle of *Pereneospora trifoliorum.*

Besides these diseases, many other diseases of minor importance also occur on the clovers. These are varied like the root rots, rusts, etc. In short, and in general, the abovementioned diseases are the important ones present on the leguminous crops in general and the clovers in particular.

*References*

1. Allison, J. L. and Chamberlain, D. W. (1946). Cited by Dickson.
2. Drechsler, C. (1923, 1929, 1930 and 1935). *Ibid.*
3. Dickson, J. G. (1947). *Diseases of Field Crops,* I Edn. (McGraw-Hill), Pp. 225-85, 289-311.
4. Frandsen, N. O. (1943). Cited by Dickson.
5. Grove, W. B. (1935, 1937). *Ibid.*
6. Henry, A. W. (1924). *Ibid.*
7. Hiura, M. (1935). *Ibid.*
8. Hynes, H. J. (1937). *Ibid.*
9. Jones, L. R., Johnson, A. G. and Reddy, C. S. (1917). *Ibid.*
10. Irving E. Melhus and George C. Kent (1948). *Elements of Plant Pathology,* IInd Edn. (Macmillan), Pp. 278, 296-97.
12. Nishikado, Y. (1929). Cited by Dickson.
13. Reddy, C. S. and Godkin, J. (1923). *Ibid.*
14. Sprague, R. (1944). *Ibid.*
15. Weimer, J. L. (1934). *Ibid.*
16. Yegna Narayan Aiyar, A. K. (1939). *Field Crops of India.* (Bangalore Press), Pp. 121.

# NOTES

For a considerable time popularising the idea of field-days in the villages has been on the programme of the Union. Not only have the field-days been made more interesting by field competitions, group discussions and local exhibitions, but members are bringing more of their friends to attend the programmes. Even our General Body Meeting was held under the greenwood tree in a village 18 miles from Bangalore. With the programme of work chalked out by the Managing Committee of the Union and the enhanced help extended to our Association by the Government, we look forward to having more of these rural field-days and making them useful.

## Crop Competition

From the beginning the chief object of our Union has been that members should conduct experiments on their fields and pool together their experiences. This time Sri. K. Byatarangappa of Nelamangala raised a crop of potatoes which gave a record yield of 1,908 md. (a maund is equal to 28 lb.). He has been elected President of the Bangalore District Committee this year and he has contributed an article to this journal on the cultivation of potatoes in Mysore.

## Japanese Method of Paddy Cultivation

Demonstrations are being held all over the State of what has come to be known as the Japanese method of paddy cultivation. An outstanding demonstration was held at Arsinkunte, Nelamangala Taluk ; members of both the Houses of Legislature in the State kindly accepted the invitation of our Union and witnessed the demonstration.

The careful handling of the nursery, the saving in seed, correct spacing and straight planting in the field were generally appreciated. The use of the puddler in preparing the main plot spontaneously attracted the local farmers.

## Congress Exhibition

An event of importance was the Congress Exhibition held at Bangalore, which was in runnning for over a month. All the Sections of the Department were on show at the Agricultural Stall ; and the Union participated in the arrangement by putting up its exhibits. Cocoanuts, potatoes, tapioca products, *jola* earheads, jaggery samples and other exhibits from districts were prominent. About seven talks were held on the mike representing different sectional activities, among which one was devoted to explaining the objectives of the Agricultural and

Experimental Union and the organisation of Student or Young Farmers' Clubs.

### Young Farmers' Clubs

Young farmers (*Vidyarthi Ryta Sanghas* or *Goshties*) are now being organised in several places. Thanks to the circular issued by the Director of Public Instruction last year, the educational authorities in the districts are extending their co-operation. Student Farmers' Clubs represent an aspect of Basic Education, with this difference that they are voluntary organisations. The club at Sravanabelgola has been an outstanding one ; and even on the day of the *Mastakabhisheka* festival, an event held in that town once in 12 years, club boys were found willing to attend their plots. The Hon'ble Minister for Education and Acting Chief Minister was kind enough to visit the Club Farm, distribute badges to the students and encourage them with valuable suggestions.

### In the Project Area

The community project is now much in the news. The project area stands for a new spirit. 'Work with the farmers' is the slogan with which the extension workers are developing close contact with rural folk. In organising the villagers for a new life, Young Farmers' Clubs have aptly been taken on the programme.

The formative period has indeed suggested lines along which the movement can be made more widespread and both boys' clubs and girls' clubs are in the prospect.

M. V.

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The General Body of the Union holding its Business Meeting under the green wood tree

The Hon'ble Chief Minister of Mysore (presiding centre) and the Hon'ble Minister for Agriculture (at the mike) grace the Field-Day Assembly

Sri. K. Byata Rangappa

Visitors at the field of Sri. K. Byata Rangappa

Master Byata Rangappa. Varieties of potatoes in the foregrouud.

Field-Day Group at the potato harvest

Sri. Srikantiah in whose lands at Arsinkunte the demonstration of the Japanese method of paddy cultivation was arranged, and the Agricultural Inspector, Nelamangala (sitting), at the nursery plot.

The Assistant Director of Agriculture, Bangalore District (centre), at the paddy nursery.

Attending to the nursery beds

District workers of the Agricultural Department removing seedlings from the nursery for transplantation.

District workers of the Agricultural Department try their hands at transplanting the seedlings in the field.

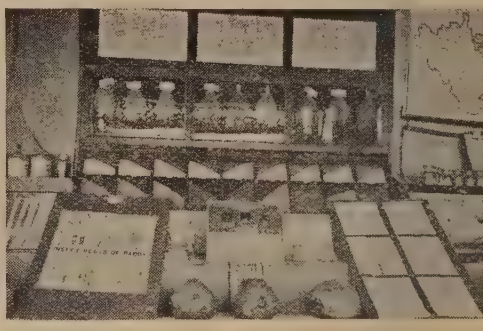
Rows of plants as straight as possible

# Congress Exhibition, Bangalore

A nursery bed of paddy raised in front of the agricultural stall in the Japanese method.

A portion of the nursery and a pot exhibit of crop besides.

Compost section of the stall



Cocoanuts and samples of paddy and rice inside the frame.

Another view. Cocoanuts, paddy and rice, and bottled exhibits.

The Union Corner

The Head Master of the Middle School at Sravanabelgola in the club garden, to whose leadership the club owed its splendid spirit.

Boys interculturing the ragi plot by the side of the Farm well

Boys working among the rows in the cabbage plot

Watering the vegetables

Village level workers at work in a field. Project area.

When the soil is prepared

Club Boys

At the drill hour